http://www.stagelefttheatre.com/wp-content/uploads/2014/11/ebisu-on-boardway-line-divider.gifCollaborative Tool: Planning for Engagement with Big Science Ideas

Note: Before using this tool, please read primer for *Planning for Engagement with Important Science Ideas.*

The series of prompts below will help you transform common topics found in textbooks, curricula, and Standards into big ideas worth teaching. The purpose of this is NOT for you to justify why you have started out with a particular topic. It is to help you *question* the topic’s importance, to *learn more* about it, *compare* it against the Next Generation Science Standards (or your current state standards), and identify the *core ideas* you will teach.

Two important notes: (1) In using this tool you will quickly reach the “edge” of your science knowledge. You should take a break from working on it yourself (after Step 1 is a good time) and start *sharing your ideas and questions* about the subject matter with some colleagues. (2) This tool is *not linear.* You will likely go back to previous steps to revise what you had recorded there. This is expected and it is a productive way to develop an anchoring event based on big science ideas for your unit.

Step 1 Start by comparing your curriculum topics against the Standards

1.1 State below what your curriculum currently identifies as the main topic (just a word or phrase), then list between 8 and 10 of the most important curriculum sub-topics you also see. Topics at this stage can initially be expressed as a process or thing or theory or concept.

Seeing the Unseen--What's the Matter?

Matter is made up of particles that are too small to be seen (5-PS1-1)

Atoms & Molecules/ elements? (5-PS1-1)

Waves- Light and Sound (4-PS3-1)(4-PS3-2)(4-PS3-3)(4-PS4-1)

Forces- Balanced and unbalances (3-PS2-1)(3-PS2-3)(5PS2-1)

Energy Transfer (5PS3-1)(5-LS2-1)

Atmosphere- Wind etc (5-ES2-1)

States of matter (5-PS1-1)

(Properties of matter)(scale and proportion)

1.2 Now identify where the topics above topics fit with the *Next Generation Science Standards* (http://www.nextgenscience.org/) or your state standards. Copy and paste below all the possible disciplinary core ideas and performance expectations that relate to your topic (this is the *only* part of the tool where you should copy and paste from another source). We used SD standards

5-PS1-1Develop a model to describe that matter is made of particles too small to be seen. (SEP: 2; DCI: PS1.A; CCC: Scale/Prop.)

5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down. (SEP:7; DCI: PS2.B; CC Cause/Effect)

5-PS3-1Use models to describe that energy in animals’ food (used for body repair, growth, motion, and to maintain body warmth) was once energy from the sun. (SEP: 2; DCI: PS3.D, LSI.C ; CCC: Energy/Matter)

5-ESS2-1 Develop a model to describe the interaction of geosphere, biosphere, hydrosphere, and/or atmosphere. (SEP: 2; DCI: ESS2.A; CCC: Systems)

5-LS2-1 Develop a model to describe the movement of matter and energy among producers, consumers, decomposers, and the environment.

￼(SEP: 2; DCI:LS2.A, LS2.B ; CCC: Systems)

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4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object. (SEP: 6; DCI: PS3.A ; CCC: Energy/Matter)

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4-PS3-2 Make observations to provide evidence for how energy can be transferred from place to place by ￼sound, light, heat, and electric currents. (SEP: 3; DCI: PS3.A, PS3.B; CCC: Energy/Matter)

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4-PS3-3 Ask questions and predict outcomes about the changes in energy that occur when objects collide. (SEP: 1; DCI: PS3.A, PS3.B, PS3.C; CCC: Energy/Matter)

4-PS4-1 Develop a model of waves to describe patterns in terms of amplitude and wavelength and to provide evidence that waves can cause objects to move. (SEP: 2 ; DCI: PS4.A; CCC: Patterns)

3-PS2-1 Plan and carry out an investigation to provide evidence of the effects of balanced and unbalanced forces on the motion of an object. (SEP: 3; DCI: PS2.A, PS2.B; CCC: Cause/Effect)

3-PS2-3 Ask questions about cause and effect relationships of electric or magnetic interactions between two ￼objects not in contact with each other. (SEP: 1; DCI: PS2.B; CCC: Cause/Effect)

1.3 Which of the curriculum ideas fit with the NGSS? How might you re-cast your curriculum ideas to better address the Standards? The Standards *take precedence* over the curriculum topics, but it is possible to teach some curriculum ideas that are not mentioned directly in the Standards.

These seem to be a fit- focus on physical properties of matter

Step 2 Moving from topics and standards toward “big ideas”

2.1 Which one of the ideas from the curriculum and Standards now seems the most central—meaning they might help explain other ideas you’ve listed and explain a wide range of natural phenomena? You must use more than a name to express your idea, *express it as a set of relationships.* Explain your choice clearly enough so a colleague could understand why you made the choice you did. To think about this, imagine filling these sentences in: *If my students could only understand how\_[core idea]\_, then they could use that to understand most other ideas in the unit. And here’ s why [give reasons for why your big ideas link to other ideas or have explanatory power].*

If you have trouble, the text in the box may help you think about how to identify what the big idea is...

Does your current choice for a central idea have a more fundamental or underlying idea that should really be the target of instruction? For example, energy transfer is what “underlies” the idea of food webs; kinetic molecular motion “underlies” the Gas Laws; and, the idea of unbalanced forces “underlies” simple machines. ALTERNATIVELY: Your topic could be a smaller part of a *larger system of activity* that is really what is important to teach. For example, in earth science the tides should be taught within the larger context of the regular movement of bodies in space and the gravitational effects of these bodies.

Big Ideas- PS1.A: Structure and Properties of Matter

All matter is composed of particles that are too tiny to be seen. We use this model as a basis to explain why 1) some materials are more dense than others, 2) some solids can dissolve in water, 3) some matter can be compressed, 4) some matter spreads out, and 5) matter expands when heated.

2.2 What about the big idea would students see as relevant to their own lives? Think about what kinds of experiences and events students have had and how the science concepts might be meaningful (not just relevant) to students. Where students encounter such ideas/science phenomena?

Indirect Evidence- the wind blowing (they can’t actually see the wind, but evidence of its movement), or finding something in the dark (senses other than seeing), a shadow flying over on a cloudy day, or tracks left in the snow/sand- but the "thing" is no longer there.

States of matter- Everything in this universe is made up of material which scientists have named “matter”. Matter is as anything that has mass and occupies volume. The particles of matter are very small, even small beyond our imagination.

Step 3 Learning more about your “big idea”

You will need to deepen your understanding of topics with which *you may think* you are very familiar. You don’t need college level textbooks, just use *Wikipedia, How Stuff Works,* the *National Digital Library* or other reputable source. Read with the expectation that you’ll have to generate a causal explanation (a “why- does-it-happen-this-way” story) for some phenomenon related to your topic.

3.1 Write below three ***new facets*** of the topic you’ve learned about and if new relationships between ideas have come to light—what ***facts, concepts, connections did you not already understand?*** Do not write definitions or formulas or trivial details; you need to UNPACK the meaning of a science idea in order to consider how to help students reconstruct the idea.

Do not copy and paste from any source.

Matter of any type can be subdivided into particles that are too small to see, but even then the matter still exists and can be detected by other means. (Indirect evidence) A model showing that gases are made from matter particles that are too small to see and are moving freely around in space can explain many observations, including the inflation and shape of a balloon and the effects of air on larger particles or objects.

An atom is the smallest unit of matter that has the properties of an element. (5-PS1.1)

Atoms are made up of a nucleus (proton/neutron) and electrons. (5.PS1.1)

Protons and neutrons are made of up even smaller particles. (5.PS1.1)

Atoms work together to make molecules.

The amount (weight) of matter is conserved when it changes form, even in transitions in which it seems to vanish. (5-PS1-2)

Measurements of a variety of properties can be used to identify materials.

Step 4 Coordinating an important phenomenon (Anchoring Event) with its explanatory model

Now we return to selecting an anchoring event or process (the observable world) and the underlying causal model for those events (the unobservable world). Answer these two sets of questions that help establish a relationship between the two.

4.1 What is an actual, observable event or set of events that students can come to a deep understanding of over a period of days? Explain why students will find this puzzling and not just an exercise found in a textbook. DO NOT NAME A CONCEPT, NAME AN ACTUAL EVENT THAT UNFOLDS OVER TIME, EVEN IF IT IS A BRIEF AMOUNT OF TIME.

Upside down container with paper towel into larger water tank does not get wet?

4.2 Give the event some context. How can the phenomena be made into a context-rich case of something “local” or “personal” to students rather than being a generic science idea? Can earthquakes, for example, be about the case of the Nisqually Earthquake? Can food chains be about the case of the decline of the Orca populations in Puget Sound? Can cell division be about a case of wounds healing in an athlete?

4.3 Now outline a causal storyline for this phenomenon. Use the abstract or unobservable characters, events, properties to form the explanation. This should be a “gapless” explanation that is just beyond what you think students at your relevant grade level might be capable of.

4.4 *In addition* to the written explanation, create on a separate piece of paper a diagrammatic/pictorial template for the explanation that you’d ask students to draw into. You can break the model into “before, during and after” sections, or you can compare two events side-by-side. Below this template, include a list of key observable and unobservable features.

Step 5 What success looks like

In this final step, you should imagine what your students will be able to do if they are successful in understanding the big idea and engaging in scientific practices. Look at how the performance expectations are written in the NGSS—they require students to both use a scientific practice (or more than one practice) and also to understand a set of specific science concepts.

Write two performance expectations for your students that pair up one or more scientific practices with the understanding of key concepts. Because modeling, explanation and arguing with evidence are at the heart of authentic disciplinary work, your performance expectations should include these three, either individually, or in combination with one another in a performance expectation.